

**SMALL ON-BOARD ENVIRONMENTAL DIAGNOSTIC SENSOR  
PACKAGE (SOBEDS)**

**Robert Redus  
John O. McGarity  
Alan C. Huber  
John A. Pantazis**

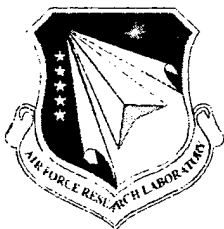
**Amptek Incorporated  
6 DeAngelo Drive  
Bedford, MA 01731-3010**

**11 November 2003**

**Scientific Report No. 8**

**20040429 087**

**APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED**



**AIR FORCE RESEARCH LABORATORY  
Space Vehicles Directorate  
29 Randolph Rd  
AIR FORCE MATERIEL COMMAND  
Hanscom AFB, MA 01731-3010**

---

This technical report has been reviewed and is approved for publication.

/Signed /

---

KEVIN P. RAY  
Contract Manager

/Signed /

---

ROBERT A. MORRIS  
Branch Chief

This document has been reviewed by the ESC Public Affairs Office and has been approved for release to the National Technical Information Service (NTIS).

Qualified requestors may obtain additional copies from the Defense Technical Information Center (DTIC). All others should apply to the NTIS.

If your address has changed, if you wish to be removed from the mailing list, or if the addressee is no longer employed by your organization, please notify AFRL/VSIM, 29 Randolph Rd., Hanscom AFB, MA 01731-3010. This will assist us in maintaining a current mailing list.

Do not return copies of this report unless contractual obligations or notices on a specific document require that it be returned.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 11-11-2003		3. REPORT TYPE AND DATES COVERED Annual 10/1/02 - 10/1/03
4. TITLE AND SUBTITLE Small On-Board Environmental Diagnostic Sensor Package (SOBEDS)			5. FUNDING NUMBERS Contract Number: F19628-95-C-0227 Program Element Number: 63401F Project Number: 2822 Task Number: GC Work unit Number: AM	
6. AUTHOR(S) Robert Redus, John O. McGarity, Alan C. Huber, John A. Pantazis				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Amptek Inc. 6 DeAngelo Drive Bedford, MA. 01730			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Research Laboratory 29 Randolph Rd. Hanscom AFB, MA 01731-3010			10. SPONSORING/MONITORING AGENCY REPORT NUMBER  AFRL-VS-HA-TR-2004-1020	
11. SUPPLEMENTARY NOTES Contract Manager Kevin Ray/VSBXR (781-377-3828)				
12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for public Release; Distribution unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  This report contains the summary of the scientific and engineering work performed during the most recent year as part of the development of the High Energy Proton instrument (HEP) and of the Low Energy Particle and Dosimetry instrument (LEPDOS). These instruments are part of the SOBEDS suite of instruments being developed by Amptek, Inc. The purpose of the HEP instrument is to measure the energy spectrum of energetic protons, specifically to obtain a differential spectrum for $25 < E < 440$ MeV and integral counts for $E > 440$ MeV. The purpose of the LEPDOS instrument is to measure: 1) the lower energy protons and electrons that may cause spacecraft anomalies, specifically protons from 0.7 to 80 MeV and electrons from 5 to $>250$ keV, 2) the dose and dose rate experienced by spacecraft electronics, 3) particles causing single event effects, and 4) to provide real-time warnings to spacecraft and operators of environmental conditions likely to cause anomalies, such as surface charging and deep dielectric charging. During the most recent year, the seventh year of the contract effort, no spacecraft were selected for the remaining instruments. Since the bulk of the remaining effort is spacecraft specific, very little work was carried out on this contract.				
14. SUBJECT TERMS High energy proton, Low energy particle, Dosimetry, ESA, LEPDOS, HEP			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT U	18. SECURITY CLASSIFICATION OF THIS PAGE U	19. SECURITY CLASSIFICATION OF ABSTRACT U	20. LIMITATION OF ABSTRACT UU	

## INTRODUCTION

This report contains the summary of the scientific and engineering work performed during the most recent year as part of the development of the High Energy Proton (HEP) instrument and of the Low Energy Particle and Dosimetry (LEPDOS) instrument. These instruments are part of the SOBEDS suite of instruments being developed by Amptek, Inc. The purpose of the HEP instrument is to measure the energy spectrum of energetic protons, specifically to obtain a differential spectrum for  $25 \leq E \leq 440$  MeV and integral counts for  $E > 440$  MeV. The purpose of the LEPDOS instrument is to measure: 1) the lower energy protons and electrons which may cause spacecraft anomalies, specifically protons from 0.7 to 80 MeV and electrons from 5 to  $>250$  keV, 2) the dose and dose rate experienced by spacecraft electronics, 3) particles causing single event effects, and 4) to provide real-time warnings to spacecraft and operators of environmental conditions likely to cause anomalies, such as surface charging and deep dielectric charging.

The first five years of this contract effort included the research, development, and fabrication of three flight LEPDOS units, including one with an ESA (electrostatic analyzer), and a flight HEP unit. At the conclusion of this five-year effort, the instruments were as complete as possible, without specifying a spacecraft interface<sup>1</sup>. The second five-year portion of the contract is to cover spacecraft specific engineering efforts, spacecraft integration, and initial flight support. This effort cannot proceed until the AFRL/VS BX contract manager chooses the specific spacecraft and the contract manager tasks Amptek to carry out the spacecraft specific work. One of the instruments, the LEPDOS with ESA, has been integrated on a spacecraft and was launched during the sixth year of the contract effort.

During the most recent year, possible spaceflight opportunities were selected for the remaining instruments. The bulk of the effort this past year involved evaluating these possible opportunities. We discussed the spacecraft interface requirements with the contractors, making clear the unique requirements of our instruments and understanding their requirements. We outlined the possible interface design and estimated the cost and schedule to implement. We supported trade studies being carried out by AFRL/VS BX.

### High Energy Proton Telescope (HEP)

The HEP instrument consists of two separate packages, a sensor head and an electronics box. Both the flight sensor head and an engineering model sensor head were completed during the initial effort. They are fully completed, including the sensors themselves, the electronics, and the package. The electronics box consists of five major electronic sub-assemblies: an analog board, a DSP board, a CPU board, an I/O board, and power supply board. Flight analog, DSP, and CPU boards have been completed. The onboard software, I/O board, and Power board are all spacecraft specific. Therefore, they are in protoflight configuration, pending specification of the spacecraft interface. HEP is in storage in Amptek's vault, pending assignment of a spacecraft. During the most recent year, the DSX spacecraft has emerged as a likely flight opportunity. Thus far, we have discussed how we would carry out the spacecraft interfacing efforts. We will support further spacecraft interfacing efforts when directed by the technical monitor.

### Low Energy Particle and Dosimetry Instrument (LEPDOS)

Three flight LEPDOS instruments were developed during the initial phase of this contract. Two units, S/N 004 and 005, are now in storage at Amptek. Both units contain power supply boards suitable for a standard 28V power bus. S/N 004 contains a MILSTD-1553B serial telemetry interface, while S/N 005 contains an asynchronous RS422 serial telemetry interface.

In the past year we have provided some support to AFRL/VS BX as they examine possible spacecraft opportunities. A HEO flight opportunity and the DSX spacecraft are now considered likely opportunities. Both would be synchronous serial RS422 interfaces, so would require custom hardware and software. Further, it is now anticipated that both would require ESAs. Thus far, we have discussed how we would carry out the spacecraft interfacing efforts. We will support further spacecraft interfacing efforts when directed by the technical monitor.

---

<sup>1</sup> A summary of the first five years is found in AFRL-VS-TR-2001-1620, *Small On-Board Environmental Diagnostic Sensors Package (SOBES)*.